Final report

(1) An outline of the issue, problem, interest, or need for each project.

Identify raw product with sugar and amino acid profiles that allow anticipated acrylamide limits to be met. All current US potato varieties used for chip manufacturing exceed 275 ppb of acrylamide, which is a threshold that has been identified by California courts.

(2) How the issue or problem was approached via the project(s).

The project is composed of three elements—the collection and shipping of potato samples to be tested, the testing itself, and the analysis of results. Samples out of storage were tested for acrylamide. In one portion of the project the potatoes were tested after harvest for asparagine.

(3) How the goals of each project were achieved.

The first experiment was to determine acrylamide levels of uniform samples subjected to various chip-processing methods. The cooperating chip processors were the laboratory of Dr. David Douches, MSU potato breeder in the Department of Crop and Soil Sciences; Techmark, Inc., a Lansing, MI technology company; and three commercial chip manufacturers, Utz Quality Foods, Inc., Hanover, PA; Herr Foods, Inc., Nottingham, PA; and Lance Manufacturing, LLC, Charlotte, NC. Four varieties were processed from four separate dates out of storage for 80 data points replicated three times for a total of 240 analyses. These chips were then forwarded to the University of Wisconsin-Madison's laboratory for acrylamide testing.

The second experiment was to determine acrylamide levels from 12 different varieties of potatoes sampled from 12 storage dates at the Michigan Potato Industry Commission's Cargill Demonstration Storage for 144 data points replicated three times for a total of 432 analyses. These chips were shipped to Madison for acrylamide testing.

(4) Results, conclusions, and lessons learned for each project.

A number of important relationships emerged from this research. First is that varieties differ in their overall acrylamide levels in processed chips. Secondly, the processors have an influence on the acrylamide levels in the processed chips. Third, the types of processing (continuous, kettle and test batch) differ in their acrylamide levels in the processed chips. Interestingly, the kettle fry process led to the processed chips with the lowest levels of acrylamide. This was contrary to our expectations prior to the study. Additional points that we learned are that varieties differ in potato chip acrylamide levels despite having similar glucose levels. Oil temperature, dwell time and process type all interact to affect moisture content and acrylamide content in the chips. Lastly, low levels of acrylamide have the potential to be achieved in kettle chips if the right variety is used. It will be more difficult with continuous chip processing at this present time.

(5) How progress has been made to achieve long-term outcome measures for each project.

This study has provided data that has helped us design a current study to confirm some observations from the past study and look more precisely at some other observations. We plan to share this data with our industry and the participating processors so they can learn from this study too. Secondly, the data will help us apply for USDA/SCRI funds and direct our studies in that proposal.

(6) Additional information available (*e.g.* publications, Web sites).

Size and scope of project reduced due to 2009 crop harvest conditions.

The overriding issue for reduced sampling was the quality of the 2009 crop. The cold season and harvest period left many potatoes unacceptable for processing. This included experimental samples from the research plots. All tuber samples were collected and were processed through Techmark for glucose and sucrose values and fry color. In many cases the tubers had high sugars, hence poor processing quality. Collecting data on high sugar potatoes would not yield usable data. Processors already know that high sugars lead to high acrylamide levels.

The goal of this project was to understand the level of acrylamide found in the chips made from potatoes under normal growing conditions. The 2009 crop conditions, particularly the month of October, were cold and wet. One grower reported that he was able to harvest only eight days in the month of October 2009.

The size of the experiment was reduced by sampling fewer varieties over a shorter time period to adjust for the quality of the 2009 crop. This greatly reduced the size and scope of our study since there was no value in testing poor quality potatoes for the acrylamide analysis.

This study is intended to help identify potato varieties that could lower the acrylamide levels in finished snack products. Studies were only done on potatoes that would allow us to test our study objectives on variables that are major contributors to acrylamide levels in snack products manufactured from potatoes under normal growing conditions.

Budget Categories

Laboratory Analysis Fees

Chipped Potatoes for Acrylamide	
Budget	$12,000.00
Actual	$ 345.00
Reimbursement requested	$ 345.00

Invoice: 1071066

Explanation: The Michigan potato industry annually contracts with Techmark of Lansing to conduct various tests on potatoes stored in industry-owned demonstration storages. We cannot break out the portion that is specific to this project. The total amount of the contract with Techmark for 2009 is $21,330. However, specific invoices covering the chipped potatoes for acrylamide cannot be cleanly separated from other invoices. The only charge that is separate is the above amount that covers six analyses for specific gravity amounting to $345.00.

The grant has two studies. The large study, referred to as the processor study, was conducted to examine the relationship of many variables upon acrylamide formation in processed potato chips. We looked at variables such as potato line, processor, processing method, tuber glucose level, tuber sucrose level, chip defects, tuber dry-matter content, processing temperature and processing time (dwell time). The second study, referred to as the variety study, was conducted to look in more detail at the effect of variety and also storage time on acrylamide formation using only a single processor (Techmark).

Out-of-Storage Potatoes for Acrylamide

Budget	$21,600.00
Actual	$18,000.00
Reimbursement requested	$18,000.00

Invoices: 5281001, 728001, 1001-2009

Explanation: The potatoes used for the processor trials were samples pulled from the bins at the Cargill Demonstration Storage owned by the Michigan Potato Industry Commission and also from a commercial bin at Sackett Farm. The storage environment was chosen to represent commercial storage conditions. In this way, the data generated could be related to commercial activities conducted by the potato industry.

Analysis for Asparagine

Budget	$12,000.00
Actual	$ 1,120.00
Reimbursement requested	$ 1,120.00

Invoice: 36382

Explanation: The amino acid asparagine content of potato tubers was measured for the four lines. Asparagine interacts with the glucose reducing sugar to create the byproduct acrylamide. Asparagine is measured by an extraction process followed by measurement on an HPLC lab machine. The company Covance will provide standardized procedures to conduct the measurement. Two sets of tuber samples of the four varieties were in the processor study. The larger cost of asparagine testing was to be for the variety study.

The poor quality of the tuber samples for the study was noted. The reason for the poor quality was the unusually cold and wet 2009 growing season. It was determined that the size of the planned variety study would be reduced significantly since the full data to be collected would be compromised. As a result, a smaller subset of the study was conducted.

Travel

Budget	$ 1,500.00
Actual	$ 990.00
Reimbursement requested	$ 990.00

Invoice: 2010-32

Explanation: The potatoes for the study were stored at the MPIC Demonstration Storage adjacent to the Montcalm Research Farm and also at the storage bins of Sackett Farm. Each sampling period a team of people traveled from campus to conduct the sampling.

Data Analysis/Final Inspection/Supervision

Budget	$12,400.00
Actual	$13,180.00

Shipping sample/contingencies	$ 100.00
Supplies for tuber sample/chip	$ 500.00
Potato tuber sampling	$ 3,380.00
Chip processing sample	$ 1,200.00
Sample organization	$ 400.00
Data management	$ 1,600.00
Data analysis	$ 3,200.00
Report writing	$ 1,600.00
Supervision	$ 1,200.00
Total	$13,180.00
Reimbursement requested	$13,180.00

Invoices: 2010-23,24,25,26,27,28,29,30,31

Explanation: A large part of the labor associated with this project took place at Michigan State University. The personnel involved in the tuber sampling were from MSU. This sampling occurred from October through May on two-week intervals. Trips for tuber sampling ranged from two to six personnel depending on the sampling work. MSU was one of the designated chip-processing sites. During the processor study, chips were fried every two weeks. Procedures were followed to obtain chip moisture readings for the MSU and Techmark chip samples.

All chip samples from the processors and Techmark were sent to MSU for handling and sample processing. Tubers for asparagine testing were packaged and shipped from MSU as well as the crushed chip samples for acrylamide testing. Prior to sample chip crushing, the samples were organized and sorted to facilitate the sampling process and insure proper identity. To prepare the samples for acrylamide testing, the samples were ground using personal electric grinders, and the ground chips were transferred to disposable 15ml sealed containers that were labeled with proper identification. Samples were shipped to the University of Wisconsin-Madison Food Lab for acrylamide analysis. Data was sent by email to MSU upon completion of the sample set. Three separate sets of samples were submitted. The acrylamide data was combined with the sample data that was collected at chip processing time. A large spreadsheet of data was created that was used for the data analysis. The data analysis was performed, and data summary and figures have been created in PowerPoint. Dr. Dave Douches served as the MSU project manager and supervised the technical staff and provided guidance on the data analysis. The data collected in the grant has allowed us to examine the importance of variety, processor, processing type, tuber glucose concentration, storage period, tuber asparagine concentration, chip defects, processing temperature, processing (dwell) time, and chip moisture content on acrylamide formation in finished potato chips. This data has helped us focus and design a follow-up study for 2011.

Total	$33,635.00
Total reimbursement requested	$30,000.00

(7) Contact person for each project with telephone number and e-mail address.

Ben Kudwa, Executive Director
517 669 8377

Dr. Dave Douches, Michigan State University
517 355 0271 ext 194